Metal Treating

NOVEMBER
DECEMBER 1958

THE *ONLY* MAGAZINE DEVOTED EXCLUSIVELY TO THE HEAT TREATING INDUSTRY

This vacuum furnace produces high temperature alloys which are oxidation-resistant. (See page 2.)

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METAL TREATING INSTITUTE

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NEW METALS AND PROCESSES

By **ROBERT C. BERTOSSA,** Senior Metallurgist
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TODAY'S ADVANCES in engineering and design make it mandatory that new materials be developed to meet specifications which, until recent years, were not considered practicable.

This is especially true in the field of metallurgy.

In spite of considerable progress made since World War II, metallurgists are largely unable to supply metals and alloys of sufficiently high properties to satisfy jet engine and missile designers.

The so-called "super alloys"—the nickel-cobalt base alloys of a few years ago—are becoming obsolete for some new high-temperature jet engine applications in which metals must withstand service temperatures above their practical limit of 1700°F. The need is for materials to operate in the 1800°F to 3000°F range. No known metals have all of the properties necessary to do this. The efficiency which can be attained in modern jet engines is dependent upon the maximum cycle temperature which can be used in the engine.

"Wonder metals" titanium and zirconium, which have shown promise in the aircraft industry, are vastly inferior in high temperature properties to the "super alloys." So they cannot be considered.

To solve the high-temperature problem, a "new look" is being taken at the so-called "refractory metals," tantalum, molybdenum, columbium (niobium) and tungsten. The main advantages of these refractory metals are their high melting points and high strengths at temperatures of 2000°F-3000°F.

Advantages

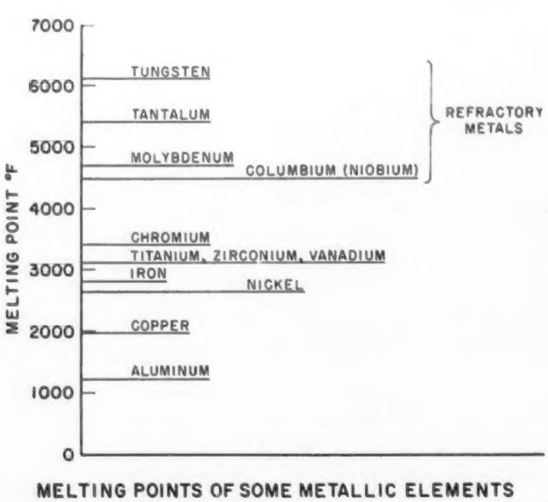
The four refractory metals (see Fig. 1) are in a group well above the melting temperatures of ordinary metals. The melting temperatures of ordinary metals are either within or only slightly above the desired service temperatures for new high-temperature applications.

All of these high-temperature metals show strengths well above 10,000 PSI at temperatures as high as 2200° F (see Fig. 2). Data above 2200° F is not available, but there is reason to believe that these metals, especially tungsten, will show satisfactory strengths up to 3000°F.

After reviewing these strengths at elevated temperatures, the question arises—Why don't the scientists and engineers get into "high gear" and use these metals in high-temperature service?

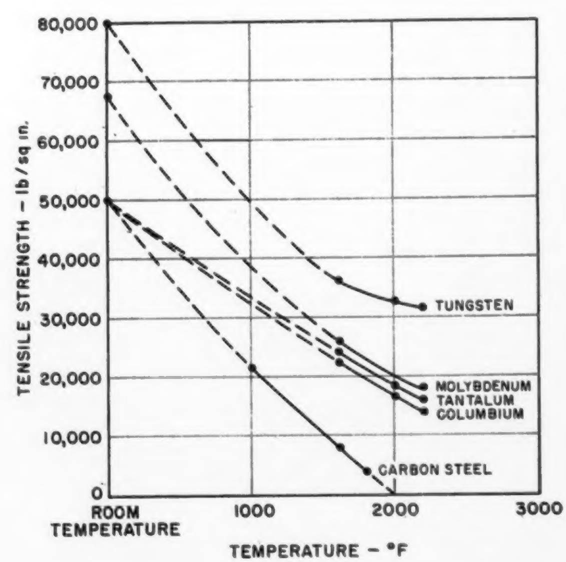
Disadvantages

This attractive idea is blunted by the fact that these



MELTING POINTS OF SOME METALLIC ELEMENTS

Fig. 1



TENSILE STRENGTHS OF REFRACTORY METALS AT ELEVATED TEMPERATURES

Fig. 2

Fig. 3—Stanford Research Institute's vacuum furnace which melts refractory metals at 6000° F.

metals also have some serious disadvantages:

1. All the metals rapidly oxidize and embrittle upon contact with small amounts of atmospheric gases at elevated temperatures.

2. When completely exposed briefly to ordinary atmosphere (in some instances a matter of minutes), they oxidize and disintegrate.

For this reason, these metals must have complete protection against oxygen, nitrogen and hydrogen in manufacture and in service when exposed to elevated temperatures.

In addition, these metals form brittle compounds with most available oxidation-resistant metals such as nickel, cobalt and chromium. This makes them very difficult to alloy or join with metals which could give protection at high temperatures.

High Temperature Research

Present high-temperature research is directed toward developing means of making these metals oxidation-resistant without decreasing their high-temperature strengths or ductility.

This goal is being approached in several different ways, all of which show promise. The first is to alloy these metals with oxidation-resistant metals to increase resistance to disintegration at high temperatures without lowering strength. This is a difficult research assignment due to the brittle characteristics of these metals in alloying with most oxidation-resistant metals and alloys. However, considerable progress has been made recently through use of vacuum melting techniques.

Stanford Research Institute's vacuum furnace (Fig. 3) melts refractory metals at temperatures of 6000°F. It produces high-temperature alloys protected from embrittlement due to gaseous contamination by maintaining high vacuum conditions during melting. The facility has been used to make improved high-temperature alloys with tungsten. These alloys are being tested as turbine blades for jet aircraft.

Another promising technique is to clad the high-temperature metals with oxidation-resistant alloys such as high chromium stainless compositions, nickel-base alloys, and some proprietary alloys.

The poor alloying properties of these metals have caused difficulties. However, through the use of thin layers of buffer metals between the high temperature metals and the oxidation-resistant clad layers, ductile multi-layer metal and alloy combinations have recently been produced in the Stanford Research Institute laboratories by new vacuum and/or inert gas cladding techniques. These claddings are being tested. SRI's laboratory-size vacuum cladding furnace is shown in Fig. 4.

High-vacuum brazing techniques are being utilized in the metallurgical research department of the Institute to develop a transition from laboratory to commercial-sized clad plate. This approach shows considerable promise at this time.

Other approaches are: plated metal coatings, ceramic coatings and metal diffusion coatings. Thus far

Fig. 4—A laboratory-sized vacuum cladding furnace.

there has been limited success because of porosity in plated coatings and lack of ductility in ceramic and cermet coatings.

Another method which shows promise is the high-temperature diffusion of some oxidation-resistant metals into the surfaces of refractory metals. For reasons already discussed, the development of this technique also presents many difficult problems which have not been completely solved.

At this point another question comes to mind: Are these newly-developed alloys and multi-metal clad combinations satisfactory for high-temperature service?

Testing Equipment

Some of the latest equipment for testing materials

Fig. 5—The Institute's solar furnace at Menlo Park, Calif.

at high temperature is available at the Institute. The Institute's solar furnace at Menlo Park, California, (Fig. 5) has a lower set of glass mirrors, which track the sun through a device called a "Heliostat". This ground level mirror concentrates and reflects the sun's rays into a concave mirror in the upper portion of the structure.

The concave mirror further concentrates the rays into an extremely hot cone, into which the specimen to be tested is placed. It can attain temperatures as high as 6000°F. Under test at around 5500°F, very little can be seen other than considerable smoke and a small molten puddle in the center of a tantalum specimen (see Fig. 6).

SRI's arc-image furnace is similar in principle to the solar furnace except that it concentrates the heat energy

Fig. 6—A smoking, molten tantalum specimen under test at 5500° F in the solar furnace.

provided by a carbon arc. This furnace can attain a temperature of around 4300°F at the tip of the cone, and is being used for high-temperature testing of metals and ceramics. (The arc-image furnace (Fig. 7) is shown testing a bi-metal clad material produced in SRI laboratories. The high-strength metal shown is tantalum.)

Other test methods are being used, such as oxy-hydrogen and oxy-acetylene flames. These are considerably lower in maximum temperature than the solar and arc-image furnaces, but can be made to cover a larger test area. Some newer devices have been built in the Institute's laboratories for attaining even higher temperatures.

SUMMARY

Considerable effort remains to be exerted before the full high-temperature strength potential of tungsten, molybdenum, tantalum and columbium can be utilized. Rapid progress is being made, however, through several lines of attack,

Ideally, the solution would be to develop refractory alloys of the high-temperature metals which retain their properties of high strength and have resistance to oxidation at temperatures from 2000° to 3000°F.

This approach is being tested at the Institute, along with the high-temperature cladding approach in which refractory metals are clad with oxidation-resistant metal layers. • • •

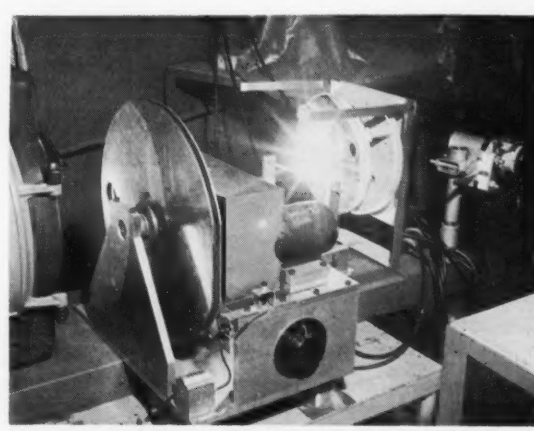


Fig. 7—An arc-image furnace for testing bi-metal clad material.

FORGING AND HEAT TREATING PRACTICES FOR ARMCO 17-7 PH STAINLESS STEEL

By **W. J. DAVISON,** Metallurgical Department
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Forging Practice

1. This alloy must be re-heated more often during forging than stainless steels that are not directional, to minimize cracking.
2. To prevent end cracking during flattening or drawing out stock the slugs should be hot sheared instead of cold sawed.
3. Peripheral cracking during upsetting can be eliminated by controlling the amount of upsetting between reheatings and by lightly working the periphery during upsettings. Try a series of hot working ratios between re-heatings to determine the maximum upsetting permissible between heatings without causing cracks.
4. Using flat dies to forge rounds from squares can cause center rupturing. Use of swaging dies is recommended. Flat dies may be used if the material is thoroughly soaked and the hammer blows are light.

Designing Forging Procedures

Bar stock of Armco 17-7 PH is anisotropic because of its inherent two-phased microstructure. Therefore, it has markedly different properties when tested in the several axes of the bar. Particularly, the ductility of bar stock is very low in directions other than the longitudinal. This is not true of sheet, strip and plate, which possess satisfactory ductility in the long-transverse direction (width) even though the microstructure is similar to that of bar stock.

The ductility of bar stock has to do with the relationship between the applied stress and the directionality of the microstructure or grain flow. Poor ductility is obtained when testing across the grain flow and satisfactory ductility when testing parallel to the grain flow.

The same relationship exists in forgings; the ductility is a function of the relationship between the grain flow and applied stress. Designing forging procedures to produce a particular configuration must include consideration of the amount of hot work necessary to produce satisfactory grain flow in critical areas rather than merely finding the most economical procedure for obtaining the configuration.

As an example, to produce the illustrated biscuit forging, the easiest method is shown in Figure 1. Using this procedure, the ductility of the mid-radius (test location) would be poor. The ductility at the mid-radius of Figure 2 would be satisfactory, but it would be more expensive to produce because much more forging would be required. The data in Table I illustrate this point. Although the two final forgings are of different sizes, they indicate the level of mechanical properties expected at the mid-radius of the two sketches shown in Figures 1 and 2.

The important consideration in designing forging procedures to obtain satisfactory mechanical properties is this: the part being forged must be hot worked sufficiently to produce the proper grain flow in critical areas. It is not possible to be more specific on this point because of the multitude of shapes and sizes produced. When initially forging a new part, several degrees of forging should be tried to find the amount of hot working required to obtain satisfactory ductility where needed.

Regarding grain flow, once a piece has been improperly forged, no heat treatment is known that will compensate for poor design. Poor forging design precludes the probability of consistently obtaining satisfactory mechanical properties. Conversely, if the parts are satisfactorily forged, improper heat treatment can result in low ductility or strength.

Heat Treating

Necessity for proper control of temperature during any heat treatment is recognized, but the reason for some of the other requirements of 17-7 PH is not obvious. Hence, a brief summary of the metallurgy of the alloy as affected by heat treatment may be useful to heat treaters because this metal is metallurgically complex and requires very special care.

Solution Treatment:—Condition A

Armco 17-7 PH can be either austenitic or martensitic at room temperatures, depending on the temperature of the prior heat treatment. The M_S point(1) is a function of the solution treating temperature. After solution treating at 1900° F, the M_S point is below —100° F; whereas after temperatures below 1850° F and above 2050° F, the M_S point increases and can be above room temperature. Solution treating at 1900° F is recommended with variations between 1850° F and 1975° F allowable. Water quenching after solution treating is recommended, but air cooling is permissible.

After forging, solution treating is necessary so that

(1)The M_S point is the temperature at which the austenite starts to transform to martensite on cooling.

a uniform austenitic matrix(2) will be available before the transformation treatment (1400° F). Any martensite in the structure before the 1400° F treatment becomes highly tempered while at 1400° F and that part of the structure will not properly harden subsequently.

Transformation Treatment:—Condition T

Upon heating to 1400° F ±25° F, carbon precipitates out of the austenite into the ferrite and austenite grain boundaries. This unbalances or destabilizes the austenite, so that on cooling the M_S point is about 250° F. On cooling to 50-60° F, the transformation is virtually complete. The austenite conditioning (transformation) can be done at other temperatures, but the strength and ductility probably will not be within the limits expected. The time at 1400° F was arbitrarily set at 1½ hours as a compromise for obtaining satisfactory strength and ductility levels. Longer or shorter times result in slightly higher or lower strength and slightly lower or higher ductility respectively.

Cooling from 1400° F must be sufficiently fast to insure that the material is cooled to below 60° F within one hour. If cooling to 60° F is delayed, part of the austenite may become stabilized and will not transform to martensite. This results in lower strength. In some cases when cooling is delayed, cooling to a lower temperature results in transformation of the stabilized austenite. With normal cooling procedures, cooling to below 50° F is not recommended because the ductility is lowered; however, the strength is improved. Armco's mill practice is to air cool for one hour and then immediately "quench" in water at 50-60° F to insure compliance with this requirement. Material is held in the water for about one hour as a safety measure.

Aging Treatment:—Condition TH 1050

The precipitation-hardening constituent is submicroscopic and believed to be an aluminum nickel compound. This compound is soluble in austenite but not in martensite. Hardening occurs when the martensite, which is formed on cooling from the 1400° F heat treatment, is subsequently reheated in the range of 600-1100° F. Simultaneously, the martensite is being stress-relieved or tempered. Maximum strength occurs when aged at 900-950° F, but the ductility is low. Higher temperatures improve the ductility but at the expense of strength.

Aging at 1050° F for 1½ hours is again a compromise between strength and ductility. The permissible temperature variation at 1050° F is ±10° F because the properties vary significantly if aged beyond these limits. A time longer than 1½ hours reduces the strength only slightly, and shorter times result in slightly lower ductility.

The 1400° F and the 1050° F treatments are arbitrarily set heat treatments. They are necessary only to insure meeting the guaranteed mechanical properties. In the Armco mill, material is tested using these procedures, and material is approved assuming that forgers

REQUIRED SHAPE

This forging requires good ductility in the mid-radius area when tested parallel to the forged faces. Radial grain flow at the mid-radius will satisfy this requirement.

Fig. 1

This low upset ratio is economical but does not provide sufficient hot work to provide the required grain flow at the mid-radius.

Fig. 2

The high upset ratio caused sufficient metal movement to provide the radial grain flow at the mid-radius.

will heat treat similarly to obtain the guaranteed properties. If desired, the heat treatment can be varied to obtain higher strength or ductility.

Conditioning Treatment:—Condition R

If forgings are to be heat treated to Condition

(2) Although the matrix is austenitic, the alloy always contains about 5-15% of delta ferrite which is not significantly affected by heat treating.

RH-950, the same attention to details of the recommended practice is necessary to insure meeting the expected mechanical properties. The forgings are first solution treated as discussed previously. They are then heated to 1750° F ±15° F for ten minutes and air cooled. During this heating only a slight quantity of carbon precipitates out of the austenite. This alters the M_S point so that it is at room temperature. If the temperature is much higher than 1750° F, the M_S point will be too low to completely transform the austenite on cooling to -100° F. If the temperature is too low, ductility will be lowered. A longer time at 1750° F is not necessary; it only results in a slightly lower strength. Cooling to -100° F insures full transformation to martensite. Unlike carbon steels, this transformation depends partly on time; hence the eight-hour requirement at -100° F to insure full transformation.

In order to prevent stabilizing the austenite before the -100° F treatment, cooling to -100° F is recommended as soon as possible after the 1750° F treatment. A time delay up to 24 hours will not materially stabilize the austenite if the material is kept at 70° F or above during the interim.

Aging Treatment:—Condition RH-950

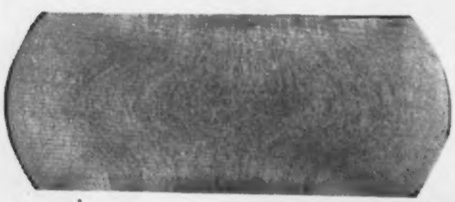
Heating at 950° F is similar to the 1050° F treatment. The simultaneous stress-relieving and precipitation-hardening produce the desired mechanical properties. Higher temperatures result in better ductility, but at the expense of strength. Longer times at the higher temperatures also improve the ductility. A longer time than one hour at 950° F has no significant effect on the properties.

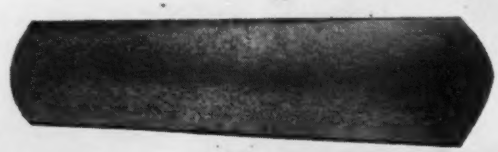
Armco PH 15-7 Mo

Armco PH 15-7 Mo is essentially the same alloy (metallurgically) as Armco 17-7 PH except that about 2% of the chromium is replaced with about 2% molybdenum for better elevated temperature properties. The heat treatments for this alloy are the same as those used for Armco 17-7 PH. • • •

TABLE I

EFFECT OF AMOUNT OF HOT UPSETTING ON THE DUCTILITY OF ARMCO 17-7 PH





Initial Size	4 x 4 x 4-1/4"	4 x 4 x 7-1/2"
Final Size	5.5" dia. x 2-5/16"	9-1/2" dia. x 1-1/4"
Upset Ratio	1.9:1	6:1
Final Diameter to Height Ratio	2.4:1	7.5:1

Mechanical Properties

UTS, psi	180,000	180,000
.2% yield, psi	No yield attempted	150,000
Elong., %	2.0	11.0
Red. in Area, %	2.0	30.0

Both samples were heat treated to Condition TH 1050. The example on the left was purposely forged to provide a poor grain flow to study the effect of heat treatment on ductility in poorly designed forgings. No heat treatment was found which would consistently provide satisfactory ductility in the biscuit.

The example on the right was purposely upset more than necessary to preclude the detrimental effect of poor grain flow on the ductility in that experiment. This biscuit has parallel sides; the angle of the photo distorts the shape of the biscuit.

ECONOMIC ADVANTAGES OF ELECTRIC FURNACES

By **WALTER H. HOLCROFT,** President
Holcroft & Company
Detroit, Michigan

IN THE FIELD of industrial heating equipment, we have what at first glance may appear to be a strange competitive situation. For one thing there are at least six possible heating methods applicable to industrial heating.

(1) *Resistance Heating*—Used to heat parts of relatively uniform cross section by the direct passage of electrical current through them. One variation of this would be in flash welding.

(2) *Direct Gas Firing*—Flame impingement localized to selectively heat gear or sprocket teeth or similar spot applications. Entire pieces of fairly uniform section may also be heated in this manner. This is directly competitive with the next method.

(3) *Induction Heating*—Coils are used and frequency may vary from 60 cycles up.

(4) *Infra-Red Heating*—Used extensively in drying paints. Source of heat is generally electric although some gas is reported as being used.

(5) *Salt Bath Heating*—Parts are heated by conduction in molten salt bath. Salts may be such as to be neutral to the metal being treated or may have carburizing or nitriding properties. The salt baths are contained in metal or ceramic containers and may be heated either by gas or electricity.

(6) *Furnace Heating*—Parts are heated in a refractory-lined structure by radiation and convection. When a single charge or load of work is heated and processed at one time, we call the operation a batch operation and generally refer to the furnace as a batch furnace to distinguish it from a continuous furnace in which successive loads pass continuously through the processing zones.

Then, in addition to this situation, furnaces may also be classified according to industrial applications:

1. Laboratory Furnaces
2. Ceramic Kilns and Glass Lehrs
3. Tempering Furnaces
4. Non-Ferrous Heat Treating Furnaces
5. Brazing and Sintering Furnaces
6. High Speed Steel Heat Treating Furnaces
7. Ferrous Heat Treating Furnaces

Before considering the specific advantages of each class of electric furnace, we should examine some of the advantages inherent in any electric furnace.

Advantages of Electric Furnaces

1. *Low Initial Cost*—It has been a misconception for years that electric furnaces are always more expensive than equivalent fuel-fired units. Actually when total installation costs are considered, electrically-heated furnaces are often the least expensive.

   The reason for this misconception has been that until recently it was common practice for furnace manufacturers to quote fuel-fired furnaces less piping, wiring and exhaust systems, thus making the apparent initial cost low. At the same time it has been customary to quote expensive transformers with electric furnaces, leaving only the wiring to be done by the customer. Generally, even with this method of quoting, electric furnaces have been competitive; but if total cost figures are used, then electric furnaces often have the price advantage. This is a point well worth remembering when considering different types of furnace installations.

2. *Good Working Conditions*—Electric heating has two distinct advantages over fuel firing in industrial furnace installations. First, the lack of combustion fumes and excessive heat given off by exhaust gases; and secondly, the area around electric furnaces is usually cleaner than with other types of furnace installations. Overhead areas are free from extensive exhaust systems which of necessity interfere with plant heating problems in the winter and cooling in the summer.

   This interference is seldom considered in evaluating the factors in favor of electric heat. However, the exhaust system on gas-fired furnaces should not be directly connected to flues and as a result will pull out air from the building in which

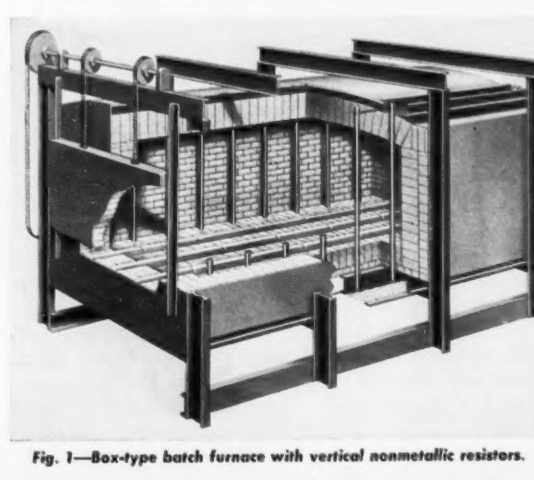


Fig. 1—Box-type batch furnace with vertical nonmetallic resistors.

the furnace is located. In winter, the air replacing that drawn out by the exhaust system must be heated; and in summer, with more factories being air conditioned, not only must replacement air be cooled but additional cooling equipment is required to take care of the added heat radiation surface of the exhaust ducts.

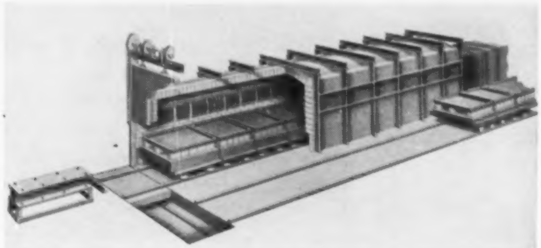


Fig. 2—A continuous car-type furnace heated by sidewall-mounted cast elements.

3. *Low Maintenance*—Normally, electric furnaces have lower maintenance costs than similar fuel-fired units. One reason for this is that electric heating elements do not have to be continually cleaned and adjusted as does combustion equipment. Another factor usually not considered in conjunction with maintenance is tampering. Electric heat is not normally subject to as much unauthorized or unwanted tinkering as in fuel-fired equipment. For some reason, burner equipment is usually a prize attraction for the "handy Andy" type of worker.

   Properly designed heating elements are very easily removed for quick repairs and often with little interruption to the production schedule.
4. *Good Control*—There can be no doubt that electric heating ranks high in controllability. Input can be easily varied to give the results desired. It can also be reset easily to duplicate any particular results necessary.
5. *Safety*—Safety is a problem that is daily becoming more important to industry. The cost of safety equipment and installation on fuel-fired industrial furnaces has easily quadrupled in the past few years. The number of combustion safeties required is increasing at a very rapid rate. Combustion safety arrangements that three years ago or even three months ago were considered safe by insurance and plant safety personnel no longer will pass inspection. Even so with all the safeties we are now using, gas-fired furnaces occasionally do blow up. Here electric heat with its minimum safety requirements has one of its biggest advantages.

   In addition, specially-trained personnel are not required to "light up" the furnace. This is doubly important because this work is usually done on a premium time basis. Furthermore, light-up personnel need not wait around the furnace to relight the burners if they go out while the furnace is still cold.
6. *Heating Costs*—With the constantly increasing use of protective atmospheres in furnaces, the cost of electric heat can be very favorably compared with the cost of gas heat in the high temperature range of 1700° F and over. When heating with gas-fired radiant tubes, the temperature of the combustion products leaving the radiant tube must always be in excess of the tube radiating surface temperature. With a furnace operating at 1700° F, the exit gas temperature may be as high as 2000° F. The heat carried away by the combustion products represents a very large heat loss and thus greatly reduces the efficiency of fuel-fired equipment.

   Normally in this temperature range, radiant tube fuel efficiencies cannot be expected to exceed 40%. In other words, 1000 B.T.U. per cubic foot of natural gas will only deliver 400 B.T.U. to the furnace interior. If gas is priced at 80¢ per thousand cubic feet, the cost is 80¢ per 400,000 B.T.U. or 1¢ for 5,000 B.T.U. This is the equivalent of ⅔ of a cent per kw of electricity.

   When you remember that the use of radiant tubes increases radiation loss from the furnace walls and requires motors for combustion air and vent blowers, and further consider the better power factor you get with the use of electric heat, the comparison is not unfavorable.

Types of Furnaces

To help in discussing the specific advantages of electric furnaces for different industrial applications, photographs of various types of furnaces and their descriptions will show different stock handling methods and ways of installing heating elements. It should be kept in mind that other handling methods than those illustrated may be used for the industrial application mentioned.

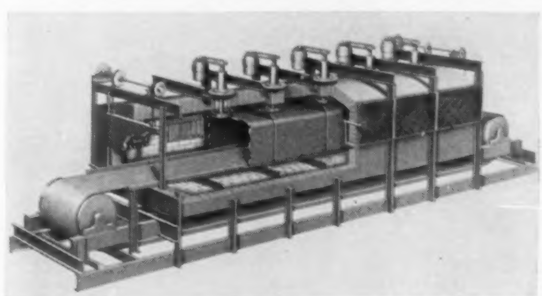


Fig. 3—A continuous conveyor-type furnace with sidewall-mounted ribbon elements.

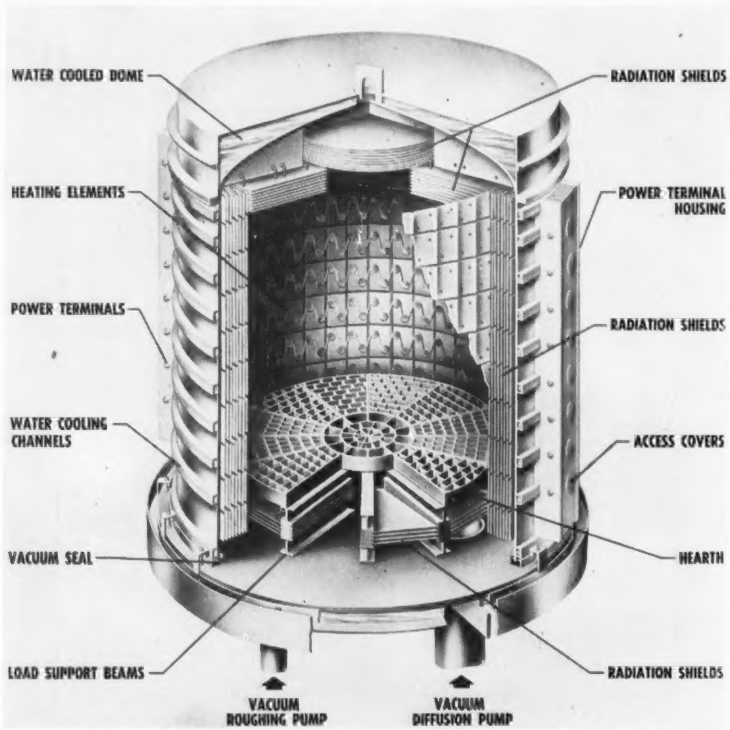
Fig. 1 shows a box-type furnace heated by vertically mounted nonmetallic resistors for batch operation. This type furnace is ideal for laboratory use. Furnaces can be factory-assembled and tested, transported into the customer's laboratory and merely with a power connection be ready to go. They can be allowed to idle unwatched during non-working hours or if shut down, can be brought

(Continued on page 29)

NEWS TO HEAT TREATERS...

VACUUM FURNACE WITH METAL SHIELDS

High vacuums, temperatures up to 2700°F and fast response in heat treat and brazing cycles can be obtained in a new electric bell-type furnace developed by the General Electric Co. Cylindrical metal shields instead of brick insulate the inside walls.



Quick heat-up and cooling cycles are characteristics of the new furnace which is used principally for heat treating super alloys of stainless steel and refractory metals such as titanium and zirconium. Since there is no insulating brick, a high vacuum can be quickly obtained and easily maintained.

The furnace casing is water jacketed to keep it cool, thus retaining strength to withstand atmospheric pressure while the work load is at very high temperatures. Losses due to convection are reduced by the vacuum in the furnace. Protective gas atmosphere can also be used in the furnace.

The radiation shields of heat-resisting alloy metal are arranged in several layers of concentric cylindrical shells on the inside walls of the heating chamber. The top and bottom have separated layers of alloy sheets in a horizontal position. The metal forms a complete enclosure around material being heat treated, retarding heat losses from the furnace due to radiation.

For further information circle No. 1

ALLOY STEEL POCKET TEXTBOOK

The fourth edition of a booklet entitled "Quick Facts About Alloy Steels," published by Bethlehem Steel Company, is now available. The booklet has taken on the character of a textbook and, because it is small and handy, it can be carried in the pocket for quick reference to the nine tables of AISI and SAE specifications for open-hearth and electric furnace alloy steels—bars, billets, blooms and slabs. Among the important subjects treated are "What is an Alloy Steel?" "Effects of Elements"; "Grain Size"; "Heat Treatment"; "Determining Depth Hardness," etc.

For further information circle No. 2

SINTERING AT 2200° C. (4000° F.)

Sintering of powder metal parts compacted of materials with a very high melting point, such as tantalum, and degassing of components such as tungsten elements for electronic tubes, which require equally high temperatures, are both practicable in a new cold-wall vacuum heat treating furnace developed by F. J. Stokes Corporation, Philadelphia.

Designed to operate successfully at temperatures up to 2200° C. (4000° F), the new Stokes cold-wall furnace is suitable for both experimental work and for small-scale production. It is a compact unit of approximately desk-top height, 5 ft. 4 in. long, and 4½ ft. wide. Within the vacuum retort, which is 20 in. in diameter and 20 in. deep, is a hot zone 3½ in. in diameter and 6½ in. deep, produced by a resistance-heated radiant cylinder. This hot zone is surrounded by a multi-layer reflective shield, which in turn is surrounded by a water-jacket.

For further information circle No. 3

PROPANE DILUTER

To maintain heat processing operations, space heating, water heating, cooking or refrigeration during periods of fuel cutoff, Selas Corporation of America, Dresher, Pennsylvania, is now marketing a Propane Diluter, which automatically supplies accurate mixtures of propane and air, or butane and air.

Available for small, medium and large installations, Propane Diluters provide simplified interchangeability without having to adjust appliances or gas burners. They can be connected to existing gas piping and eliminate the expensive need for dual piping, separate air blowers, inspirator mixers, or the like.

The design of the Propane Diluter incorporates a balanced pressure, full-floating mixing valve with precision machined gas and air metering ports. The valve is adjusted through a vernier type worm-wheel mechanism for precise control of gas-air ratio and is capable of turndown through a range of 50:1.

For further information circle No. 4

NEW KNOCK-DOWN GANTRY "A" FRAME

The marketing of a new line of patented "knock-down" type 'Budgit' Gantry "A" Frames in 1- and 2-

ton capacities has just been announced by Shaw-Box Crane & Hoist Division of Manning, Maxwell & Moore, Inc., Muskegon, Michigan.

Each unit comes in a shipping carton 8" x 11" x 120", is compact, easy to carry, easy to assemble and easy to store. No special tools are required and two men can easily assemble and erect either model in less than an hour.

These new "A" frames, when equipped with a hoisting unit, make a sturdy, mobile lifting device for handling loads up to their rated capacity. The floor is their track, and because their movement is not confined to overhead supports or rails, they can be used anywhere lifting service is required. When desired, the units can be dismantled and stored in a convenient place.

An American Standard Section I-beam can be purchased with the unit as a separate item or can be procured locally. The 1-ton models require 6" x 12.5 lb. I-beams while the 2 ton models use 8" x 18.4 lb. I-beams. The beam on all models can vary in length but not exceed 12'-6".

For further information circle No. 5

NEW BRAZING UNIT

A new custom-engineered shuttle type brazing unit designed and fabricated by Gas Appliance Service, Inc. of Chicago, is stepped up production of heating and cooling coils. This new gas-fired unit brazes U-shaped return bends on the coils, using pre-placed silver alloy rings, and produces uniformly brazed joints on every coil. It has two combination loading and cooling stations, one on each side of the heating station, served by a two-position, air-operated carriage, equipped with adjustable support fixtures. Multiple gas burner heads, adjustable to accommodate various sizes of coil, are automatically operated as coil is moved into the heating station. Heating is automatically timed and when brazing is completed, the coil is moved back into the loading station where an automatically timed blast of air speeds the cooling operation.

Meanwhile, another coil, from the loading-cooling station on the opposite side of the unit has moved into the heating station.

The unit not only automatically produces uniformly brazed coils at

from 40 to 50 units per hour, but, by concentrating heat on the return bends, produces no distortion of the aluminum fins of the coils. One man loads and unloads the unit and operates the carriage by push-button. A Furkert Gas/Air Mixer supplies the proper mixture of fuel, which is natural gas and air.

For further information circle No. 6

EASY-OPEN INSULATION CARTON

The opening and emptying of a carton of block insulation, heretofore a job requiring several minutes, has been reduced to 20 seconds by a newly developed method of packaging introduced by the manufacturers of GRIPTEX Mineral Wool Block Insulation.

The carton is composed essentially of twin sections held together by bands of tape with plainly marked ends. Opening is accomplished simply by grasping the ends and ripping off the tape—a 20-second operation.

Besides saving time and reducing block breakage, the two-section carton permits the contents to be divided into two equal loads, thus facilitating handling by the applicator. GRIPTEX is the "king-size" high-temperature block insulation offered by the M. H. Detrick Company.

For further information circle No. 7

April—Ammonia storage tank installed without supervision by supplier "Z"...

Later—Leaks! Getting improper flow of ammonia . . .

Still later—Discovered certain vital equipment improperly installed . . .

Too late—Safety and efficiency at danger point, shut down line to make repairs . . .

Be trouble-free—be sure Armour Ammonia experts help supervise your cylinder and storage tank installations!

Armour's Technical Service plus a consistent purity of 99.98%—on delivery—from 163 stock points and 8 bulk stations make Armour your one best source for trouble-free ammonia. For further information on cylinder or storage tank installations, write us on your company letterhead.

ARMOUR AMMONIA DIVISION

1353 West 31st Street • Chicago 9, Illinois

CHROMATE POWDER

Heatbath Corporation has introduced a new versatile and inexpensive chromate powder called Duracoat H-6-2 for producing iridescent golden chromate finishes on zinc and cadmium plate as well as on zinc die castings.

Duracoat H-6-2 solution is made up using only 2-4% Duracoat H-6-2 per gallon of water and requires no separate additions of other liquid acids for make-up or during use. The iridescent golden chromate films produced are claimed to be extremely corrosion resistant and serve as excellent bases for painting. Low cost, long life and ease of control are said to be outstanding features of this new product.

For further information circle No. 8

ALLOY DISTRIBUTOR EXPANDS

Rolled Alloys, Inc., a leading distributor of heat-resisting alloy steels, has purchased a large area of the former Packard properties in Detroit. The new plant, with an area of over 43,000 square feet of floor space, will be provided with 2 ten-ton cranes, to operate in an open bay 60 x 324 feet.

Executive offices of the company will be headquartered in Detroit and will be located at 5309 Concord, adjoining the warehouse. Rolled Alloys, Inc., having only started business in 1953 have already grown to be what is claimed as the largest warehouse distributor of heat-resistant steels in the United States. Offices are maintained in eleven cities, and sales Metallurgists cover the entire nation.

FLAME HARDENING EQUIPMENT

Six types and sizes of gear and pinion used in excavation and concrete machinery are flame-hardened on production-scale test equipment in the Selas Corporation of America laboratory at Dresher, Pa.

Tests shown established 4½ to 10 min. heating cycles, depending on gear size, to produce a hardened tooth surface of hardness Rc 56 after water spray quenching. Hardness follows tooth contour. It is confined to surface region, with controlled zone of transition to Rb 95 in the unaffected portion of the gears.

This flame-hardening equipment closely simulates production conditions faced by many heat treaters. Gears and other cylindrical workpieces up to 34 in. O.D. can be heat treated. Gas-air burners of radiant (pictured) or high-velocity jet types may be used for heating followed by water spray or oil or water immersion quench.

For further information circle No. 9

CORROSION RESISTANT PLATINGS DEVELOPED

New developments in metallurgy make available to industry platings for ferrous metals and copper providing maximum resistance to corrosion, oxidation and abrasion simultaneously as well as characteristics for unique and very wide application. Plated mild steel will serve where only stainless steel would do.

Developed under the name Pyro-Plates, a nickel composition of paint-like consistency is brushed, dipped or sprayed on any ferrous metal or copper. Special preparation and masking is unnecessary other than a clean surface. High wetting action and an organic suspension is said to assure good adhesion to the base metal during processing; drying occurs in minutes. Heated by furnace or induction to 1650°F in an endothermic, exothermic, natural gas or hydrogen-reducing atmosphere, the coated object is plated with a self-fluxing nickel alloy fused or brazed into the surface of the base metal.

The plating claims a number of unique attributes. Thickness may be varied from .0005" to more than .005 by viscosity of the paint and method of application. Subsequent coats result in greater thickness. Tests exhibit the corrosion-resistant properties of pure nickel plus a self-quenching action inhibiting continued corrosion if the plate is cut or scratched through to the base metal. Pyro-Plates claim no adverse effect on exposure to an array of corrosive media even when the base metal is formed or drawn within reasonable limits. Prolonged resistance to oxidation in open air up to 1500°F is excellent.

The metallurgical bond fusing the plate into the base metal surface is said to make impossible any cracking, chipping, peeling or lifting. A 4-page illustrated brochure is available.

For further information circle No. 10

VERTICAL TRAVELING FURNACE

Large parts made from super-strength steels are heat treated to

(Continued on page 30)

M.T.I. *Activities*

J. W. REX COMPANY RECEIVES ARMY ORDNANCE CITATION

The J. W. Rex Company, Lansdale, Pa., has been awarded the Army's Certificate of Appreciation for outstanding services and achievement while producing 120 MM artillery projectiles on an Army Ordnance Corps contract.

The award was presented to Mr. J. Walter Rex, company president, by Col. Charles K. Allen, Commanding Officer of the Ordnance Ammunition Command, Joliet, Illinois.

The ceremony was witnessed by officials from the Philadelphia Ordnance District, which executed and administered the contract for the Ordnance Ammunition Command.

The Certificate of Appreciation was awarded in recognition of the company's outstanding achievement and services during the period from September 1957 through February 1958 in improving the engineering design for two types of artillery projectiles. The company produces 120 millimeter armor piercing and troop training projectiles that are fired by U.S. Army and Marine Corps heavy tanks.

Following receipt of its production order for these projectiles, the J. W. Rex Company suggested a change in the design and produced test samples for evaluation by the Army Ordnance Corps.

The design principle changes, when tested and found to produce greatly improved reliability at all expected battlefield ranges, were adopted by the Army Ordnance Corps.

In presenting the Certificate of Appreciation for Secretary of the Army, Wilbur M. Brucker and Major General J. H. Hinrichs, Chief of Ordnance, Col. Allen praised the J. W. Rex Company employees for their outstanding role in this industry-Army team effort, which has resulted in better ammunition for our troops.

J. W. Rex, President of the J. W. Rex Co., Lansdale, Pa., is awarded the "Army's Certificate of Appreciation" for the company's "outstanding services and achievement" producing 120 millimeter artillery shells. Left to right, John W. Ogden, Philadelphia Ordnance District; Thomas W. Ferguson, Jr., General Manager of J. W. Rex Co., Joseph A. Dawson, Resident Inspector of Ordnance at the company; Col. Charles Allen, Commanding Officer of the Army's Ordnance Ammunition Center, making the award; G. Clayton Rex, Treasurer; Frank E. Goeckler, Vice President; J. W. Rex; L. Frank, engineering representative for the Ordnance Center at Joliet, Illinois; and Lt. Col. R. S. Grossman of the Ordnance Center.

Other Army representatives present at the presentation included Lt. Col. R. S. Grossman, Leonard Frank, metallurgical engineer from the Ordnance Ammunition Command, and J. W. Ogden, of the Philadelphia Ordnance District.

TEXAS CHAPTER MEETS

The Texas Chapter of the Metal Treating Institute held its first meeting on September seventeeth at the Hinton Motor Lodge, Dallas, Texas. All six member companies were represented, and M. B. Dominy of Dominy Heat Treating Corp. of Dallas presided.

Topics relevant to the future of this newly-organized chapter were discussed; it was decided that the Chapter would meet three times yearly, alternating between Dallas, Fort Worth, and Houston.

MIDWEST CHAPTER MEETS

A meeting of the Midwest Chapter of the Metal Treating Institute was held on May twenty-third at Fazio's on Fifth Restaurant in Milwaukee, Wisconsin. Eleven companies were represented, and Walter Hamilton of Accurate Steel Treating Company presided.

Clarence Graham of Metal Treating, Inc. spoke of the events which had taken place at the Institute's Spring Meeting, held in Phoenix in April and gave summaries of the talks of the major speakers at the meeting.

DIRECTOR OF RESEARCH

A. T. Ridinger, President of Metallurgical, Inc., Minneapolis, recently announced appointment of Dr. Ralph L. Dowdell, professor emeritus of the University of Minnesota's department of metallurgy, as Director of Research with his firm.

Dowdell's work will place special emphasis on the guided missile field, Ridinger said.

a problem in labor arbitration taken from the files of the American Arbitration Association

The Case of the All-Around Buffer

Joe G. and Walter E. were buffers in a non-ferrous metal castings shop. Joe, the senior of the two, was as good as Walter at the buffing job, but Walter had a lot more experience at other machines in the shop. When layoffs became necessary, management decided to keep the junior man and let the senior go, on the theory that with reduced schedules it might be necessary to move the buffer around to other jobs.

The union protested, pointing out that the contract provided for seniority in layoffs where ability was "relatively equal." "The fact that Walter may be better at other jobs has nothing to do with the case," argued the business agent. "They are both relatively equal in ability as buffers, and that's all that counts."

"The ability of a man to work must be judged not in terms of his present job but in terms of the job that remains to be done when operations are curtailed," answered the personnel director. "When you look at it that way, the junior man has more ability."

Eventually the case went to arbitration.

What Would YOU Do?

THE AWARD: The arbitrator noted that the company was unable to give any firm estimate of the amount of non-buffing work that might be required. It was all a matter of guesswork and surmise. Under the circumstances, he said, the language of the contract would have to be interpreted strictly. In other words, the union was right in insisting that the senior buffer be retained.

The Case of the Disabled Driver

On March 8, 1958, Joe K. and seven other fuel oil drivers were notified they would be laid off for lack of work on March 15. Two days before the layoff was to become effective, however, Joe became involved in an accident which incapacitated him for nine weeks.

It was an occupational injury as defined in the union contract, and Joe expected he would get half his regular wage for the whole period of his disability. But the company didn't see it that way.

"The contract says we have to pay for 'lost time'," explained the personnel manager. "You're losing time until the 15th of the month, when you would be laid off. Beyond that, any time you lose is due to slack work, not to your injury."

"Lost time is lost time," answered the union business agent. "If it wasn't for the accident, Joe would be able to work for another company until you got busy again. So you have to give him disability pay as long as he's in no condition to work."

Eventually, the case went to arbitration under the Rules of the American Arbitration Association.

What Would YOU Do?

THE AWARD: The arbitrator said: "In the absence of concrete evidence to the contrary, it is presumed the parties were seeking to make the employee whole for wages *then in sight* which he lost due to injury. It is further presumed that there were no wages then in sight beyond those which *this company* would have paid, and it is clear that these would have ceased, at least for the period of the summer months, with the employee's layoff on March 15." The arbitrator admitted that this was not the only possible interpretation, but explained that it was his best judgment in a situation where there was "a most unfortunate lack of concrete evidence on the parties' contractual intent."

CAUTION: The award in these cases is not an indication of how other arbitrators might rule in other apparently similar cases. Arbitrators do not follow precedents. Each case is decided on the basis of the particular history, contract, testimony and other facts involved.

Tool Steel Topics

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Export Distributor: Bethlehem Steel Export Corporation

Lustre-Die held costs down in molding plastic covers

"We need," said the customer, "a plastic cover to protect our sealed motors. It's to be drip-proof and sturdy, yet must be a low cost item. Do you have a grade of die steel which will help us produce such a cover economically?"

The mold maker, Dollins Tool & Gage Co., Independence, Mo., put the problem up to Ford Steel Co., St. Louis, our local tool steel distributor. Quick as a flash came their recommendation: "Lustre-Die!"

The electric-furnace steel performed to everyone's satisfaction. It was economical. It took a high polish. It had high compressive strength. It machined easily. It performed well in molding the parts which were held to a close tolerance of .001 in.

Lustre-Die is just the ticket for molding plastics because its properties make possible a bright, mirror-like polish. Lustre-Die has the proper basic analysis for molding plastics. And it offers something more — alloy fortification! Lustre-Die is heat-treated by oil-quenching and tempering to augment its properties, and is furnished ready for machining and polishing.

Lustre-Die is carefully inspected to insure cleanliness. It is free from injurious porosity or surface pitting. And there's no problem about inclusion-causing additions.

Lustre-Die is a good steel to keep in mind for your next plastic-molding operation. Your Bethlehem tool steel distributor can furnish it from stock. Why not give him a call?

BETHLEHEM TOOL STEEL ENGINEER SAYS:

Here's Why Air-Hardening Steels are Good Performers

When a large group of various types of tools made from air-hardening tool steels is compared with a group of similar tools made from steels which require liquid quenching for hardening, it will be found that the air-hardened tools outperform the liquid-quenched tools in service. This result will not necessarily be found in the comparison of individual tools, but will appear if a large enough variety and number of tools are studied.

The reason why air-hardened tools outperform liquid-quenched tools can be summed up in one word — consistency. The consistent performance of air-hardened tools is evident in many ways:

DIMENSIONAL STABILITY

All tools, when subjected to the hardening operation, develop small but measurable dimensional changes (so-called distortion). Air-hardened tools not only show less dimensional change than liquid-quenched tools, but the changes that do occur are remarkably similar in each tool when identical tools are made up. By contrast, liquid-hardened tools show considerably more variation from tool to tool when identical tools are produced.

HARDNESS

Duplicate air-hardened tools invariably show the same hardness after heat-treatment. Liquid-quenched tools may show erratic hardness in various locations on a tool, due to variations in effectiveness of the liquid quench; however, duplicate tools will each have a somewhat different hardness pattern.

RESIDUAL QUENCHING STRESSES

All tools develop residual internal stresses due to the hardening operation. Liquid-quenched tools develop high internal residual stresses because of the variations in cooling rate which occur in different locations on a tool during the quench. If improperly controlled, these stresses can lead to cracking of the tools in heat-treatment or in grinding, or the load-carrying ability of the tools may be low and erratic.

By contrast, air-hardened tools develop only a low degree of internal stress during hardening, because of the comparatively uniform cooling in the quench. Furthermore, the degree of internal stress which develops is uniform from tool to tool, so that the service performance of duplicate tools is reasonably consistent.

The advantages of air-hardening steels cannot be realized, however, unless they are hardened by air-quenching. It is possible to harden all air-hardening steels by liquid-quenching (oil-quench or salt-quench as in martempering) and this is frequently done because of the convenience of existing heat-treatment equipment. However, liquid-quenching of air-hardening steels is a serious mistake, because it sacrifices almost all the basic advantages of air-hardening steels. Liquid-quenching not only increases distortion and internal stresses, but may lead to cracking of some of the tools during heat-treatment. Air-hardened steels which are properly quenched in air do not crack in heat-treatment.

Bethlehem offers a full range of air-hardening steels: Bearcat for shock applications, A-H5 for general-purpose tool and die work, and Lehigh H for maximum production runs.

THE APPRENTICE CORNER

Editor's Note: This is the third article on this topic of a series which will be published in the next several issues. They have been abstracted from the book "Injury in Ground Surfaces" by Dr. L. P. Tarasov of the Norton Company Research Laboratories with the kind permission of the publisher, the Norton Company, Worcester, Mass., who also furnished the photographs.

Typical Crack Patterns

Having shown how cracks in ground parts can be detected in the previous instalment, the crack patterns that are likely to be encountered will now be discussed. An understanding of crack patterns will be helpful in distinguishing between heat treatment cracks and those occurring during or after grinding. Of course, if all the material that is to be ground were to be inspected for cracks prior to grinding, there would be no question as to when cracks noticed only after grinding were actually formed. Since such inspection is rare, it sometimes happens that cracks occurring during heat treatment are not noticed because of scale. When this is ground off, the cracks become visible and may be wrongly blamed upon the grinding operation.

The principal distinguishing characteristics of *heat treatment cracks* are that they are fairly large and deep, and bear no relationship, unless an accidental one, to the grain marks left by the grinding wheel; on the other hand, *cracks formed during or after grinding* are small and shallow, and are definitely related to the pattern of grinding scratches. It should be kept in mind that the latter cracks are not necessarily the result of faulty grinding since improper heat treatment may stress a piece of hardened steel so much (without actually cracking it) that even a very gentle grinding operation will then crack the surface. It is impossible to tell from the appearance or the pattern of the cracks that develop during or after grinding whether they are due primarily to improper heat treatment or to improper grinding or to a combination of the two.

An example of a heat treatment crack is illustrated in Fig. 1. The crack is a very deep one and extends horizontally along most of the hardened roll, which was form ground after the bar had cracked in heat treatment. This single deep crack can be compared with the numerous fine, shallow cracks that resulted when the shaft in the illustration published previously was ground too severely.* These fine cracks are generally no more than 0.010" or 0.015" deep.

In one respect, the crack in Fig. 1 is not typical of heat treatment cracks, for it is exactly perpendicular to the direction of the grain marks, except near the right end. A definite relationship, such as this one, is purely accidental. Normally, the direction of grain marks is entirely independent of cracks formed prior to grinding. Thus in Fig. 2, the heat treatment crack in the upper portion of the ring is a circular arc, being roughly perpendicular to the grain marks near its ends and parallel to them, or nearly so, in the middle. Had the ring cracked during or after grinding,

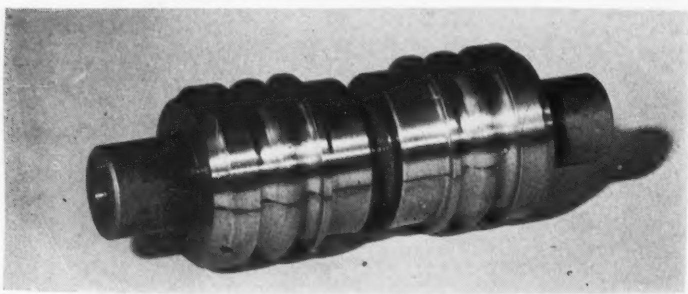


Fig. 1 (A)—Heat treatment crack in form-ground roll of hardened steel

Fig. 1 (B)—Section through roll to show depth of crack. (2/3 actual size)

Fig. 2—Heat treatment crack in hardened steel ring. (2/3 actual size)

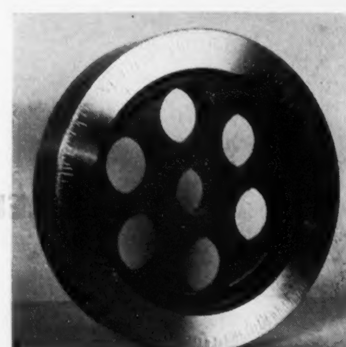


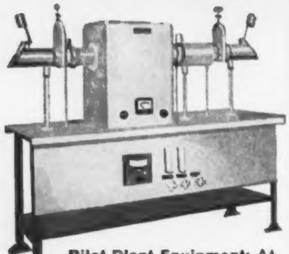
Fig. 3—Surface cracks in plug gage, resulting from a too severe grinding operation. Cracks made visible by wet magnetic particle method. (2/3 actual size)

*Refer to article in September-October 1958 *Metal Treating*, page 18.

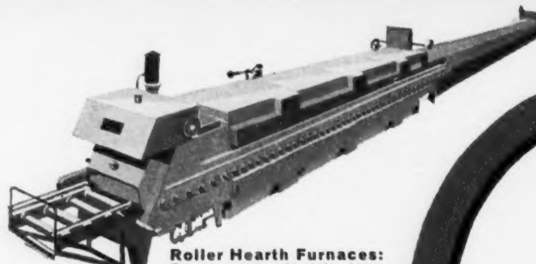
(Continued on page 41)

Wherever industry needs heat...

You'll find LINDBERG equipment just right for the specific job

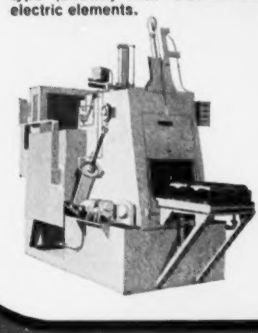


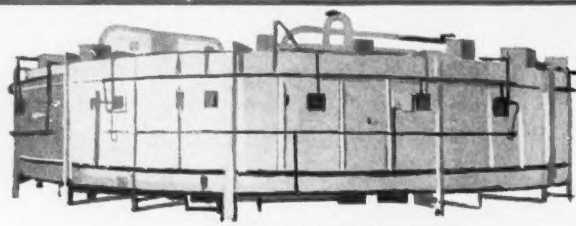
Pilot Plant Equipment: Atmosphere tube unit (shown) for processing work at temperatures to 2200° F.



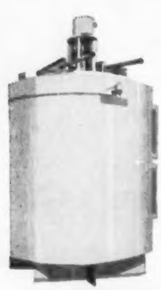
Roller Hearth Furnaces: Continuous electric type (shown) with temperature range 1300° to 2100° F.

Automatic Carbonitriding Furnaces: Automated integral quench type (shown) with CORRTHERM electric elements.



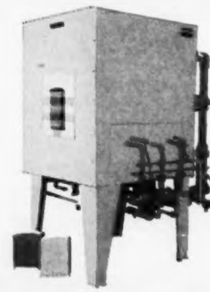


Rotary Hearth Furnaces: Doughnut type field-installed gas-fired furnace (shown) with capacity of 13,000 lbs. per hour.

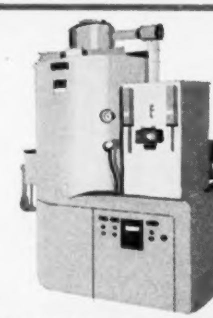


Vertical Type Furnaces: Carburizing and hardening furnace (shown) with CORRTHERM electrical heating elements.

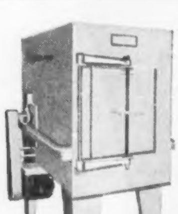
HF Induction Heating Units: Available in 5, 10, 25 and 50 KW units.



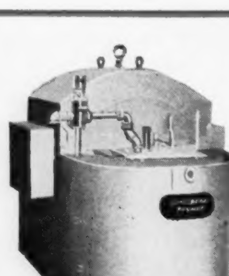
Ceramic Kilns: Gas-fired periodic kiln (shown) with temperature range to 3250° F.



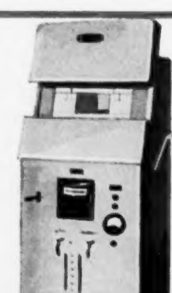
Atmosphere Generators: Hyen generator (shown) for endothermic atmospheres. Generators for all required atmospheres.



Tempering Furnaces: Box type Cyclone (shown). Temperature range to 1250° F.

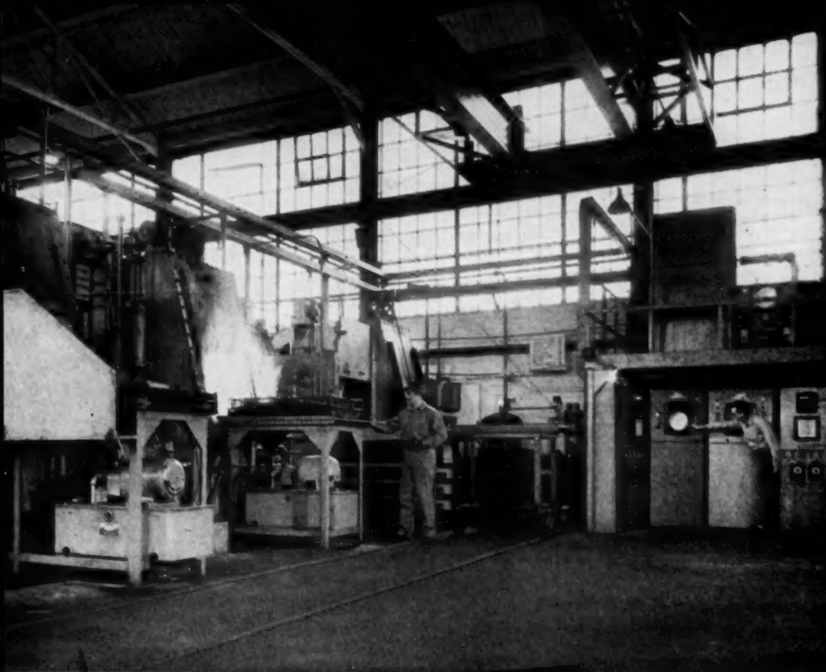


Melting and Holding Furnaces: Electric resistance furnace (shown) with capacities of 750 lbs. to 1500 lbs.



Laboratory Equipment: One-unit box furnace (shown), muffle or for non-oxidizing atmosphere with temperature range to 3000° F.

Aluminum Reverberatory Furnaces: Twin-chamber melting and holding furnace (shown) with 45,000 lbs. capacity.

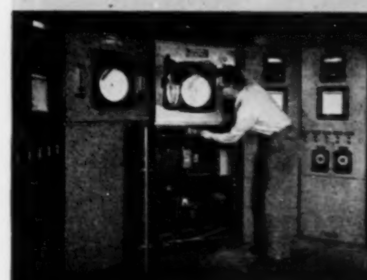


Lindberg-Designed

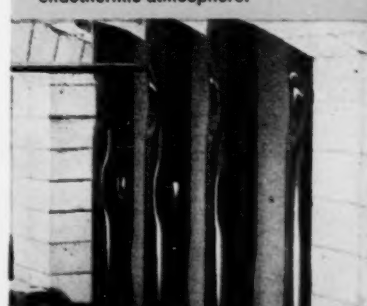
Unique Installation Cuts Heat Treating Costs and Improves Quality at Dayton

Charles Hewitt, President of Dayton, says, "The Lindberg installation has kept our production at a consistently high quality level."

Work loads are positioned manually, but entire furnace operation is fully automatic.



Lindberg Carbotrol unit automatically controls and records "dew point" and heating cycles of endothermic atmosphere.

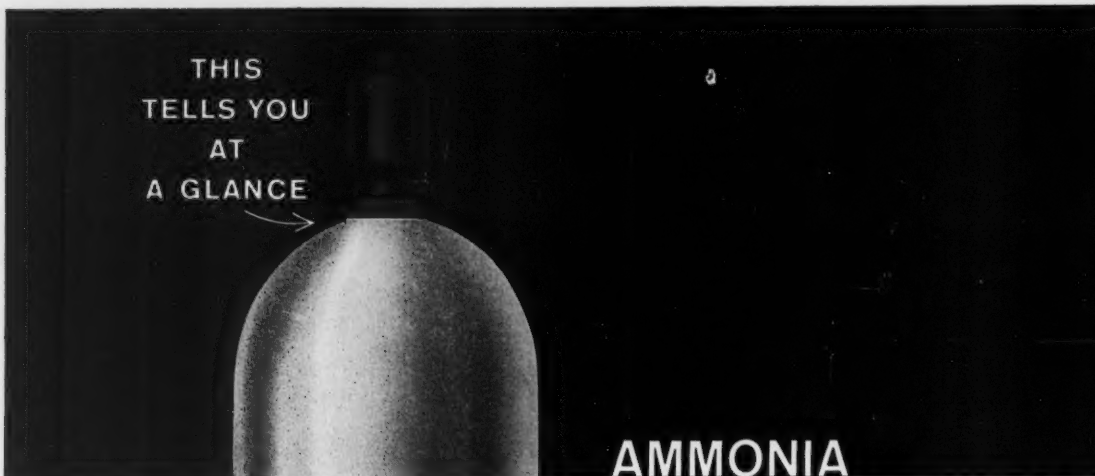


Lindberg's "dimple" vertical radiant tubes give remarkably trouble-free service and function at all times at full efficiency.

Here is a remarkable set-up for general heat treating now in operation at Dayton Forging & Heat Treating Company, Dayton, Ohio. Two integral quench atmosphere furnaces, largest of this type ever built by Lindberg, and one atmosphere tempering furnace in a "three-in-a-row" arrangement that simplifies transfer operation. Combined with Lindberg Carbotrol and Hyen generator, the entire furnace operation is completely automatic, including atmosphere control and recording. Planned by Dayton and Lindberg engineers, the installation runs around the clock, six days a week, reducing costs and producing cleaner end products, brighter job finish, freedom from "decarb" and a consistently higher quality of work.

This is another example of how Lindberg equipment and Lindberg planning can help you find the most effective answer to any problem of applying heat to industry. We cover the field, heat treating, melting and holding, tempering, brazing, enameling furnaces, ceramic kilns, high frequency units, and are in the ideal position to recommend just the type of equipment most suitable for your needs. This can be factory built or field-installed in your own plant, fuel-fired or electric, whatever is best suited to your production processes. Consult your local Lindberg Field Representative (see the classified phone book) or get in touch with us direct. Lindberg Engineering Company, 2466 West Hubbard Street, Chicago 12, Illinois. Los Angeles Plant: 11937 S. Regentview Avenue, at Downey, California.

LINDBERG heat for industry



IT'S THE PUREST, DRIEST AMMONIA YOU CAN BUY

This blue neck on the cylinder is all you need to know about ammonia to be sure it will give trouble-free service in your dissociator.

The blue band identifies Allied Chemical's BARRETT BRAND Anhydrous Ammonia – the purest, driest you can buy. Then, to make sure it's delivered to you as pure as it's made, blue neck cylinders get V.I.P. treatment at Allied: they're reserved for metal treating service only, and every precaution is taken to make sure they're free from oil or other contaminants.

Order Barrett Brand Ammonia from any of these Allied distributors:

ARKANSAS
Little Rock: Terminal Warehouse Co., 500 E. Markham St.
Thompson-Hayward Chemical Co., 3100 W. 65th St.

COLORADO
Denver: Mine & Smelter Supply Co., 3800 Race St., P.O. Box 9041

CONNECTICUT
West Hartford: The Christian Petersen & Son Co., 26 Brook St., P.O. Box 247

FLORIDA
Jacksonville: D. W. Anderson, 615 E. Bay St. P.O. Box 1346
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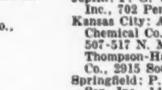
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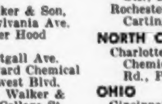
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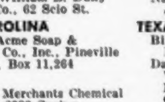
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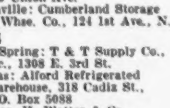
CYLINDERS

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(Continued from page 11)

up to heat rapidly without fear of hurting the equipment. Testing conditions can easily be duplicated from day to day or week to week. Venting presents no problem, and they can be moved easily from one location to another. The use of nonmetallic resistors as shown enables the furnace to operate through a temperature range from 400° F to 2400° F which is not feasible with combustible equipment. Atmospheres may be used.

Fig. 2 illustrates a continuous car-type furnace heated by sidewall mounted cast elements. This type is very popular for ceramic kilns and glass lehrs. Electric heat for these applications has the advantage of eliminating dirt or soot from combustion, a very important point where perfect surface conditions must be maintained. In addition, air rather than reducing gases enhances the pink, red and gold colors used in ceramic work. Temperatures of ceramic kilns and glass lehrs will vary from 800° F up. At the higher temperature ranges, either nonmetallic resistors or molybdenum resistors are used, and the need of heating heavy saggers which are necessary when heating with gas are eliminated.

A continuous conveyor-type furnace with sidewall mounted ribbon elements is shown in Fig. 3. For low temperature applications such as tempering, almost any method of material handling can be used. One of the more common is a conveyor-type furnace.

The first and probably the most important function of these furnaces is to produce uniform heating. For this reason, fans are used to circulate the air over the heating elements and then over the stock. Duct work is used to insure proper air flow. For good temperature control it is necessary to circulate large volumes of air at a low temperature head. Here is where the close control of heat input possible with electricity is a big advantage.

High surface area ribbon elements also have an advantage in such cases because of the rapid heat transfer they afford.

Construction of electric-heated tempering furnaces is simpler than for fuel-fired because no combustion chamber is necessary. The absence of combustible fumes also eliminates the need for expensive safety devices which are required on low temperature fuel-fired furnaces. Cost of fuel as such is a minor item on these low temperature applications.

A continuous pusher-type furnace heated by sidewall-mounted cast elements and horizontal drawer-type ribbon elements is seen in Fig. 4. This type furnace has been used extensively for the controlled atmosphere heat treating of non-ferrous metals. Operating mechanisms are very simple,

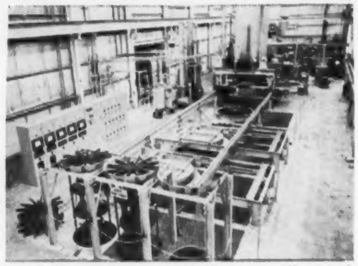
(Continued on page 34)

NEWS TO HEAT TREATERS

(Continued from page 16)

high tensile strengths at Douglas Aircraft, Torrance, Calif., with a General Electric vertical traveling electric furnace equipped with an exothermic gas generator. Some of the steels are capable of attaining tensile strengths of 260,000-280,000 psi, according to Douglas Aircraft engineers.

Working zone of the furnace is 4 feet in diameter and 10 feet high. Racked parts are raised into or lowered from the furnace by a chain. Designed and built by General Electric's Industrial Heating Department at Shelbyville, Ind., the furnace has a capacity of 3500 pounds of steel under certain conditions, according



to GE engineers. It is on rails and moves over the oil quench tank for rapid quenching or over either of two other furnaces which can be used for preheating or tempering.

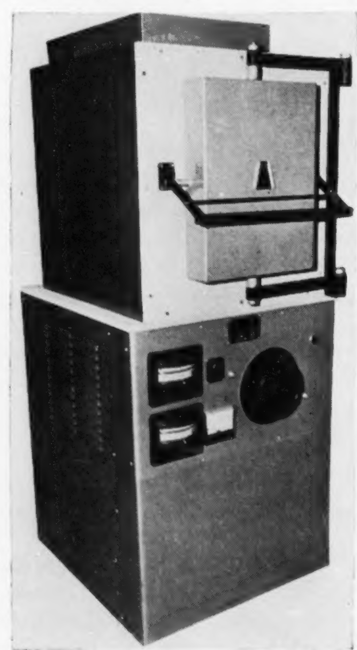
The unit is equipped with three zone control temperature regulators, one each for the top, middle and bottom zones.

The exothermic gas generator (capacity 4000 cfh) draws fuel gas and air through visual flowmeters into a gas combustion controller where the air-gas ratio is regulated. The gas passes through a cooler, a carbon dioxide absorbing tower and then enters the furnace.

For further information circle No. 11

HIGH TEMPERATURE FURNACE

K. H. Huppert Company, Chicago, has announced a new design, electrically-heated, high-temperature furnace for operation up to 3100°F without the requirement of a protective furnace atmosphere. Known as KR-SUPER, this design is the latest addition to the Huppert KR line of electric furnaces for the metallurgical, ceramic and chemical industries for laboratory and production processing.



Because of long life, non-oxidizing, non-flaking oxide coating protected elements and other exclusive features for high-temperature operation, this furnace is said to offer radically new processing possibilities on a large variety of metal,

(Continued on page 32)

NEWS TO HEAT TREATERS

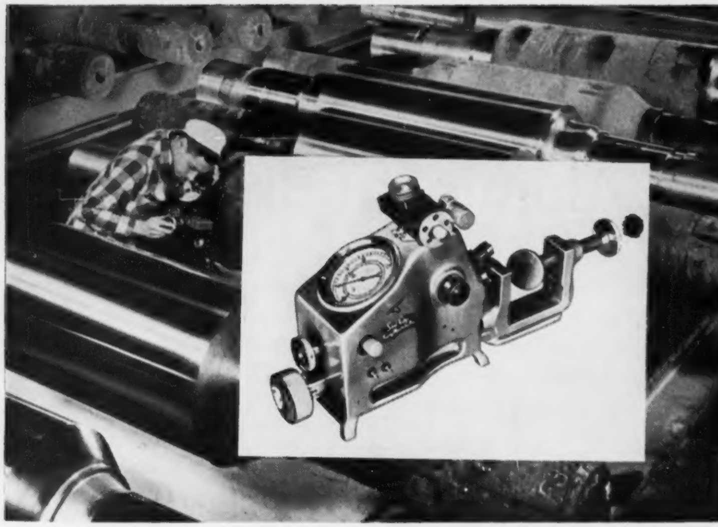
(Continued from page 30)

ceramic and chemical products.

Rugged steel casing construction combined with multi-insulation and super-high temperature chamber refractory provides long life. Vertical refractory separating piers between vertically suspended side-wall elements of the hair-pin type assure long element life and evenly distributed radiant energy to all portions of the furnace charge.

For further information circle No. 12

PENETRASCOPE PORTABLE HARDNESS TESTER



Steel City Testing Machines, Inc., Detroit, Michigan, has announced their appointment as exclusive U.S. distributor for the outstanding Penetrascope Portable Hardness Tester, manufactured in England.

Since the introduction of the Penetrascope in this country, these portable hardness testers have reportedly received extremely high praise from many leading metal-working plants for their proven accuracy and dependability. The design, procedure of using the tester, and results obtained all conform to the American Society for Testing Materials Standard E 92-57.

Penetrascope weighs approximately 18 lbs., is easily transported and has consistent accuracy even when testing in normally inaccessible places. Penetrascope is especially useful in testing finished parts because the method leaves only a minute indentation on the surface. It can be used for testing a wide range of materials from thin metal strips to large mill rolls or cylinders. Tests are made with ease on profiles, recessed surfaces and gear teeth.

All models are finished in a durable polychrome and are equipped with a mahogany carry-case for easy transportation. Interchangeable clamps are also available, including the standard U clamps of various sizes, a chain clamp and the unique Electro-Magnetic clamp.

For further information circle No. 13

(Continued on page 38)

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and atmosphere requirements are kept to a minimum by the end vestibules.

The same advantages just mentioned for tempering furnaces also apply for this classification. Different metals are processed, but the same tempera-

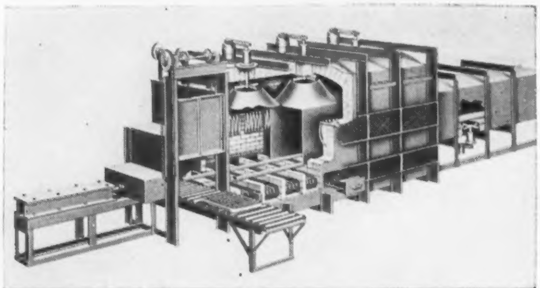

Fig. 4—A continuous pusher-type furnace heated by sidewall-mounted cast elements and horizontal drawer-type ribbon elements.

ture ranges (300°-1400°F) are used and the same temperature uniformity required. The basic difference between these classifications is in the use of a protective atmosphere.

Electricity has an advantage here of eliminating the necessity of separating the protective atmosphere and the combustion products which is generally done in gas-fired equipment by use of a muffle or radiant tubes.

Fig. 5 pictures a continuous roller hearth furnace heated by horizontal nonmetallic resistors mounted above and below the work. This type furnace is normally used for high temperature applications (usually 2000°F and up) where a protective atmosphere is required such as in brazing or in powdered metal sintering operations.

The end vestibules reduce atmosphere requirements, and the alloy rollers stand up very well at these high temperatures because the normal creeping tendency of alloys under these conditions is nullified by the rotation of the rollers. This continual turning prevents the rollers from sagging.

Due to the high operating temperature and the requirement of an atmosphere, electric heat is very advantageous.

In Fig. 6 we are shown a continuous rotary furnace heated by nonmetallic resistors mounted above the work. This type furnace is often used for high speed steel heat treating. Operating temperatures are in the same range as the last; that is, above 2000° F. These high operating temperatures are used either to heat and hold the work in this range, as in stainless steel processes, or to rapidly heat steel by means of a high thermal head. In either case, the problem of heating to and handling at high temperatures must be faced.

For that reason the non-metallic element heated rotary furnace is nearly ideal. Stock movement is accomplished by moving the entire furnace hearth. This arrangement completely eliminates the necessity of any heat-resistant alloy. This fact alone makes this type furnace very attractive. Another advantage of rotary furnaces is that they offer high production rates in a compact area with only one-man operation.

As previously pointed out, electricity is generally competitively priced in the higher temperature ranges and working conditions are improved tremendously.

A shaker hearth furnace heated by coiled elements encased in alloy tubes is seen in Fig. 7. This type furnace is used primarily for the processing of small parts such as screw machine production or stampings that cannot be damaged by sliding. The work is placed directly on the hearth which moves slowly in one direction and snaps back against a stop. The sudden jolt slides the work forward through the furnace. The parts are spread quite thin thus enabling very rapid heating. When used for controlled atmosphere processing, it gives the added advantage of exposing all parts uniformly to the furnace atmosphere without the added expense of careful loading or circulating fans.

The coiled heating elements shown are encased in alloy tubes to protect them from the sooting action of some gas atmospheres.

Fig. 8 shows a walking beam furnace with horizontal drawer-type ribbon elements. The walking beam stock moving arrangement is ideal for long shafts. They are handled individually by two sets of rails. One set is stationary. The other set lifts the stock off the stationary set, moves forward, and then drops down below the level of the stationary set before traveling back to its original position. This action is continuously repeated and "walks" the stock through the furnace.

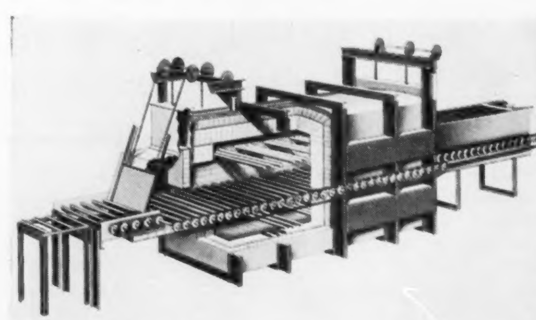

Fig. 5—Roller hearth continuous furnace with horizontal nonmetallic resistors.

The drawer-type ribbon elements work in very well with this type design because they are extremely easy to remove. So are the coiled units inside the tubes and the non-metallic bars. This ease of removal means that repairs to heating elements

(Continued on page 36)

WILSON "ROCKWELL"

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ALL WILSON "ROCKWELL" hardness testers provide these advantages:

Accurate performance—precision built, with exact calibration, for consistently correct results.

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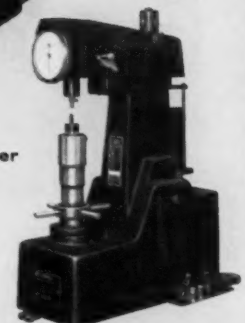

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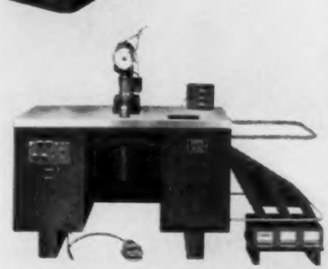

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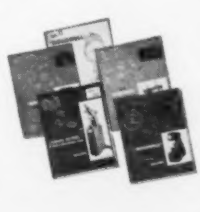

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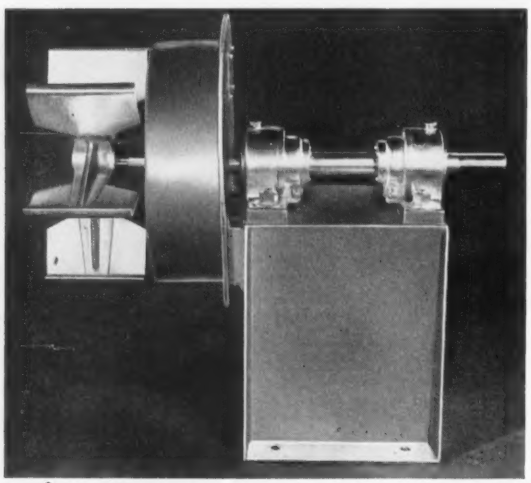

ELECTRIC FURNACES

(Continued from page 34)

can be made without cooling the furnace.

With the continuing demand for high nickel alloys in jet engines and for stockpiling, we shall find the use of nonmetallic heating elements in this temperature range will show a decided saving in hard-to-get parts.

Fig. 7 of the shaker hearth and Fig. 8 of the walking beam were but two examples of the various furnace types used for ferrous heat treating. In this class we normally are considering temperatures in the range of 1400°-1800°F. It is in this range that the use of electric heating has not been thoroughly understood.

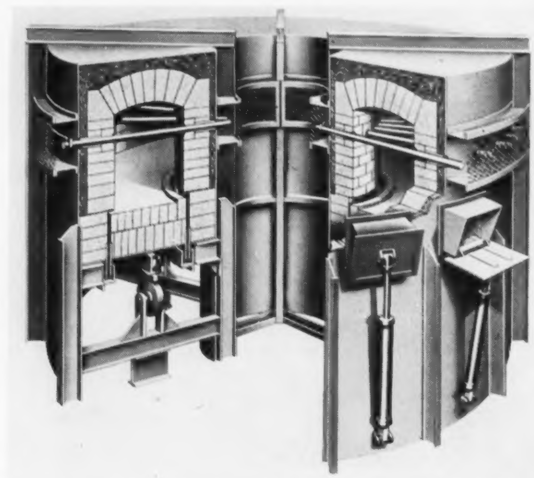

Fig. 6—Continuous rotary furnace heated by horizontal nonmetallic resistors mounted above the work.

Heating Comparisons

Perhaps one reason has been the apparent higher cost of electricity when compared to fuel-firing at these moderate temperatures. Let's look more closely at a typical comparison of fuel and electric heating. For comparison let us take a pusher-type furnace for annealing 700 pounds net per hour at 1700°F, with subsequent cooling to 350°F; atmosphere is exothermic. This furnace was quoted alternately on the basis of gas-fired radiant tube heat or with drawer-type electric resistance elements. The furnace is designed to handle one row of trays, each tray 15" x 30" loaded with 93½ pounds. Production was to be 7½ trays per hour with 64 minutes in the heating section and 120 minutes in the cooling. Tray weight is 40 pounds, and so the gross weight to be heated is 1,000 pounds per hour.

Total price of the radiant tube heated furnace completely ready for production after a single connection for electricity, gas and water, was $45,-933.00. This included all necessary vent piping.

(Continued on page 40)

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KARBO-MATIC FURNACE

...MAINTAINS MIL-SPEC UNIFORMITY AT PRODUCTION-LINE PACE!

Uniformity is built right into the Karbo-Matic! With this completely automatic Pacific Furnace, work is always held at heat the same length of time, from load-to-load, regardless of the size of the load.

Clean, high quality work continues on a high production basis with no readjustment of the controls until an entirely different job is run. Results on S.A.E. 4130 steel, as quenched, show a 52 Rockwell C consistently held within one point at Industrial Steel Treating Co. A second Karbo-Matic was recently installed in their Los Angeles plant.

Here, versatility is another reason the Karbo-Matic has proved profitable. It is approved for stainless steel treating to both military and airframe manufacturer's specifications, and is also used for carburizing, carbo-nitriding, normalizing, clean hardening, carbon restoration work as well as tool and die hardening. An automatic Pacific Endothermic Generator supplies protective atmosphere to these Karbo-Matics for a complete, balanced system.

Find out how a Karbo-Matic, electric or gas-fired, can fit into your shop. Call or write today!

DESIGN features of the Karbo-Matic... for more efficiency, more economy:

- FULLY AUTOMATIC FOR SPEED AND ACCURACY
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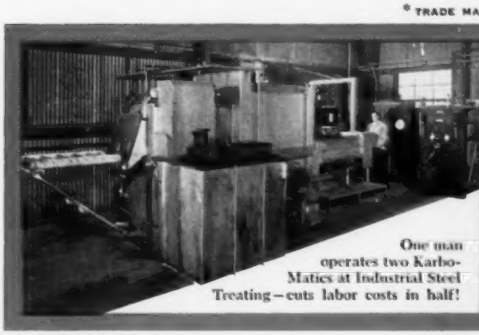

One man operates two Karbo-Matics at Industrial Steel Treating—cuts labor costs in half!

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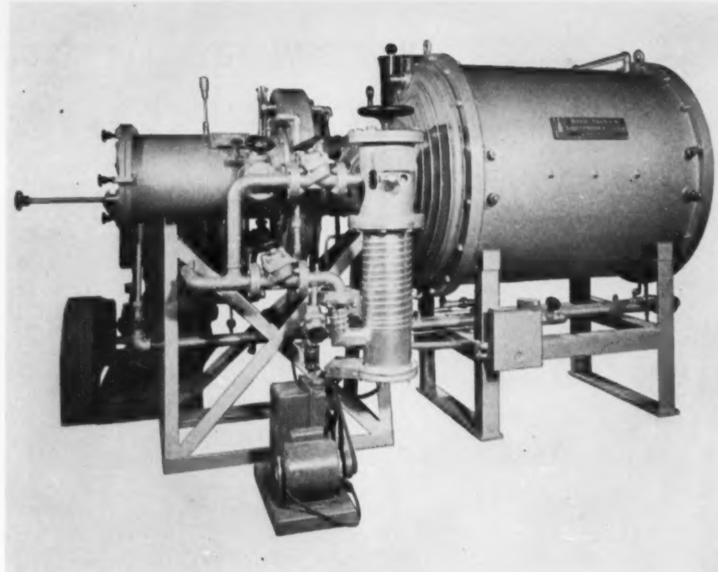
NEWS TO HEAT TREATERS

(Continued from page 32)

3000° F. INTERNALLY-HEATED VACUUM FURNACE



High Vacuum Equipment Corporation, a leading manufacturer of internally-heated high temperature vacuum furnaces, has announced a new horizontal production (12x18 in. even-heated zone) furnace, capable of operating up to 3000°F at a vacuum of 5×10^{-5} mm Hg. Furnace is designed for heat-treating, annealing, brazing and sintering.

Resistance-heated by special dual-zone molybdenum cage-type elements, this furnace is insulated by a five-layer moly and stainless steel heat shield assembly, whose low mass permits extremely rapid heating and cooling rates — approximately 1½ hours to 3000°F with 50 kw input. Faster rates are possible with larger transformers.

Close temperature control is obtained by raising power input manually with a powerstat to desired operating temperature. A control instrument then maintains uniformity ± 10°F, working through furnace contactors. Saturable reactor control is available as an option.

A loading-cooling zone, isolated from the vacuum chamber by a water-cooled vacuum gate valve, permits semi-continuous operation in which the heating rate is solely dependent on the composition and mass of the work load and fixtures. With this arrangement, the hot zone remains at constant temperature and under high vacuum at all times. An alternate arrangement, where inert atmosphere can be used, is made by installation of a special heat exchanger and blower to recirculate cooling gases. This arrangement has the advantage of fixed work load and work thermocouples, while providing most effective gas quenching.

This unit is supplied complete, including power supply, all necessary control thermocouples, work thermocouple in cold zone, vacuum pumping equipment, and separate control cubicle containing vacuum and furnace instruments, switches, relays, contactors, etc. Floor area required is 6 feet by 12 feet.

For further information circle No. 14

RESEARCH ENGINEER

Andrew Syska has joined C. I. Hayes, Inc., of Cranston, R. I., as a research engineer. He will participate in research and development of the Hayes organization's extensive line of "Certain Curtain" electrical heat treating furnaces.

Mr. Syska is a graduate of the University of London, England, and was a graduate associate at the Battersea College of Technology in London. In 1956 he came to the United States as a permanent resident, and joined the Industrial Heating Division of Westinghouse

Electric Corp., where he worked on the designing of high temperature bell and box furnaces and the development of atmosphere generating equipment.

NEW REPRESENTATIVE

Stanwood Corporation, Chicago, has announced that the Shea-Brownell Company, 3903 Olive Street, St. Louis 8, Missouri, has been appointed sales representative for Missouri and southern Illinois. They will handle the company's line of carburizing boxes, retorts, muffles, baskets, trays, fixtures, and furnace parts for heat treating equipment.

SUNBEAM EQUIPMENT CORPORATION MOVES

After over 60 years of service to the nation's metalworking industries under the name of Sunbeam-Stewart Furnaces, a new corporation has been formed known as the Sunbeam Equipment Corporation, located at 180 Mercer Street, Meadville, Pa.

This new corporation was formed as a result of Sunbeam's acquiring the Westinghouse Industrial Furnace business.

The plant and office facilities of Sunbeam will be moved from Chicago to Meadville, and the Sunbeam Equipment Corporation will manufacture and sell Sunbeam-Stewart furnaces in addition to all types formerly built by Westinghouse.

ELECTRIC FURNACES

(Continued from page 36)

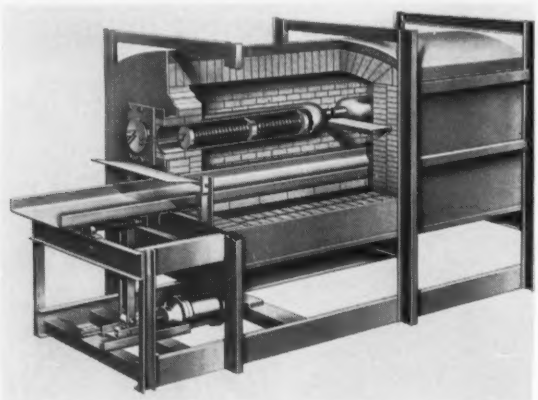


Fig. 7—Shaker hearth furnace with coiled elements encased in alloy protection tubes.

Total price of the electrically-heated furnace completely ready after a single connection for electricity and water was $43,993.00. This included necessary transformers.

Estimated heating requirement 400,000 B.T.U. per hour equivalent to 120 KW or 1,000 CFH of 1,000 B.T.U. gas.

At 80¢ per thousand cubic foot, gas cost is 80¢ per hour.

To determine what electric costs would be, consultation with your electric utilities service engineers is a must. One basic fact should be kept in mind. You get a better power factor throughout your plant with the addition of a straight resistance-type furnace load. Your cost of electricity for the furnace is not just your present rate times 120 KW required. It may be that your demand rate will not increase if furnace downtime can coincide with your normal period of peak demand. Certainly, use of discretion in bringing your furnace up to heat from cold will prevent having the full 120 KW added to your demand.

Your actual cost of electricity for this furnace will be the difference between your present bill and what your bill will be with the added load. This will almost always be considerably less than your present rate in cents per KW.

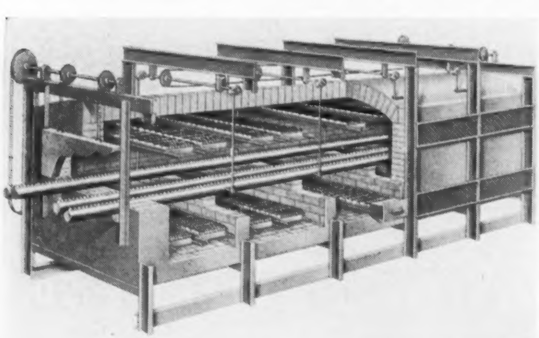


Fig. 8—A walking beam furnace with horizontal drawer-type ribbon elements.

In a comparison of costs for this particular installation, we can assume that tray replacement costs and direct labor costs will be the same for either the gas-fired or electric furnace. Therefore, a fair comparison of costs might read like this:

	Electric per Hour	Gas per Hour
Depreciation (10 years at 5,000 hours per year)	0.88	0.92
Heating		
Electric—Assume Cost Difference = 1.2¢ per KW x 120 KW	1.44	0.80
Assume 1,000 CFH 1,000 B.T.U. Gas as at 0.80		
Heating Unit Replacement Assume 3 years at 5,000 hours	0.10	0.20
Electric Motors for Combustion Air and Vent – 15 Hp total = 12 KW at 1/5¢ per KW	—	0.18
Start Up (1 per week)	—	0.20
	2.42	2.30

As you can see, most of these items require some explanation. For tax purposes depreciation is based on a twenty-year life of the equipment. Practically, however, the obsolescence factor in furnace equipment makes ten years a better figure. Obviously, if only one shift is worked we will not get 5,000 hours per year.

Start up is figured on the basis of paying a premium of four hours at premium time rates. No dollar value has been placed on safety, heating and cooling in the plant, or maintenance differentials.

Two assumptions are made relative to electric energy costs. If the present cost per KWH averages 1.5¢ then this figure should be used for extras such as requirements for fans not needed on electric furnaces. It is further assumed that using the method of added load cost results in a figure of only 1.2¢ instead 1.5¢ per KW.

We recently had an instance where the actual cost figures worked out to be only 0.8¢ per KW added and the natural gas costs 50¢ per 1,000 CFH. These figures substituted into the above comparison chart make the electric heating costs actually cheaper by 6¢ per hour than gas heating ($1.94 against $2.00).

All the influencing factors in this case worked for electric heating. Of course, every case cannot work out as favorably, but at least it shows that every case is worth investigating and then must be based on its own merits. • • •

APPRENTICE CORNER

(Continued from page 22)

the cracks would all have been more or less perpendicular to the grain marks. This perpendicular relationship between cracks formed during or after grinding and grain marks is characteristic of *flat* surfaces.

Fig. 4—Surface cracks in internally ground flat surface of hardened steel ring. (2/3 actual size)

For example, Fig. 3 shows a plug gage that was ground too severely. The numerous surface cracks are all radial and thus perpendicular to the grain marks, which happen to be circular. That such cracks do not have to be closely spaced is shown by Fig. 4, where only a few cracks, all radial, have come into existence.

Fig. 5—Surface cracks, brought out by wet magnetic particle method, in improperly ground carburized and hardened steel. Cracks are everywhere perpendicular to grain marks produced by cylindrical grinding with the side of the wheel, which was too hard for the job. (1/2 actual size)

(Continued on page 42)

APPRENTICE CORNER

(Continued from page 41)

Still another instance of the perpendicular nature of such cracks is illustrated by Fig. 5. Here the flat surface was ground on a cylindrical grinder with the side of the wheel, which left a set of grain marks tangent to a circle. The surface cracks spiral outwards and thus are everywhere perpendicular to the grain marks.

When grinding conditions are severe enough or the steel is extremely sensitive, additional cracks may appear to join those perpendicular to the grain marks and thus form a network of cracks, such as is shown in Fig. 6.

If a piece is cut off with an abrasive wheel under conditions that are too severe, such as those involving a too-rapid cut or a too-hard wheel, the surface may crack as a result. Here again the cracks tend to be perpendicular to the abrasive marks, as shown in Fig. 7 for hardened tool steel. It should be noted that even a soft metal like aluminum can be cracked if the abrasive action is too severe.

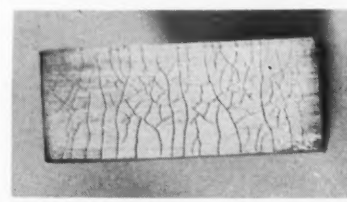


Fig. 6—Network of surface cracks, made more clearly visible by dry magnetic particle method, in hardened tool steel that was surface ground with too heavy a down feed. (Actual size)

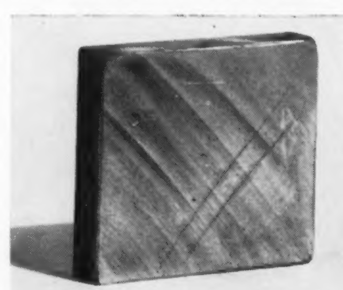


Fig. 7—Surface cracks in piece cut from a bar of hardened tool steel. Cracks resulted from use of wrong wheel, which developed too much heat. (3/4 actual size)

(To be continued)

LETTERS TO THE EDITOR

Dear Editor:

I am a tool hardener (Special duties) on the South African Railways stationed in the mechanical shops at Pietermaritzburg.

I have just received a copy of *Metal Treating* from a friend in New York, U. S. A.

It is a wonderful and very interesting magazine; the information, tips and comments are exceptionally good.

I wonder if you will let me have the privilege of being placed upon your mailing list for your very fine publication.

Hoping that you will please oblige and thanking you very sincerely for your kindness, I am

F. E. Norris
Pietermaritzburg
Natal,
South Africa

Dear Sir:

Your *Metal Treating* magazine to me is "tops."

Having just finished a Heat Treating course from I. C. S. in Scranton, I feel by receiving your magazine I can be kept well informed of the things that go on in the Heat Treat industry and so many things that pertain to my job.

Please let me know how I can become a subscriber and the cost.

Wm. E. Neff
Heat Treater
Pittston, Pa.

Dear Sirs:

I have considerable interest in being on your mailing list for your very excellent "Metal Treating" magazine and would greatly appreciate your advice on how to arrange for this.

T. W. Ruffle
Surbiton, Surrey
England

Gentlemen:

I would like to secure copies of the following in the September-October, 1957, issue of "Metal Treating."

"Heat Treating the Aluminum Alloys"
by G. W. Birdsall
"Tempering of Hardened Steel"
by K. E. Johansson and
G. Molinder

This material is required for use in an advanced Metallurgy class on heat treatment. If you could send 25 copies of each article, I will assign them to my students as required reading.

Thank you very much for your courtesy in sending these.

James R. Cady, Associate Professor
Department of Mechanical Engineering
University of Southern California,
Los Angeles, Calif.

Dear Sirs:

I would appreciate being placed on the mailing list to receive "Metal Treating." Part of my duties here include heat treating of small specialty parts, particularly springs and clips made from beryllium copper. It appears that your publication has much to offer in the way of helpful information.

Z. A. Post
Ceramic Engineer
Melpar, Inc.
Falls Church, Va.

Gentlemen:

I find an occasional borrowed copy of your magazine an invaluable aid to me in my work.

Will you please add me to the list of regular recipients.

Thank you.

David Killian
Process Engineer
Pratt & Whitney Aircraft Co.
East Hartford, Conn.

Dear Sir:

If it is possible, how may one subscribe to "Metal Treating"?

I am a Physical Properties Inspection Foreman for the U.S.A.F. and am responsible for the heat treating processes in the Heat Treating Unit. I feel that such a publication should prove very interesting and useful.

Henry P. Paul
Sacramento, Calif.

MANUFACTURERS' LITERATURE

For your copy circle the number on the Readers' Service Card

HEAT TREATING BOOKLETS

General Electric Company, Schenectady, has published several illustrated booklets which describe various heat treating processes and equipment.

Please circle the item number for the ones in which you are interested on the Readers' Service Card:

"Heat Treating Aluminum," Circle No. 15.

"Annealing of Malleable Iron," Circle No. 16.

"Temperature Control of Heat Treating Furnaces," Circle No. 17.

FINISHING DIP TANKS

Four standard models of all-steel dip and rinse tanks for precision finishing processes are outlined in a new bulletin released by Techline Division of Wheelabrator Corporation, Vicksburg, Michigan.

Two water tanks and two oil tanks are pictured in the bulletin. The inside dimensions of the tanks are 24" deep and 24" long and 16" wide. They are of double-wall construction, 40-gallon maximum capacity and come equipped with many fine features including sliding covers to protect solutions and electrical heaters, according to the bulletin.

For further information circle No. 18

HEATING IN THE STEEL MILL

Selas Corporation has published a bulletin entitled, "Gradiation Heating in the Steel Mill." This illustrated, 28-page booklet describes steel heating equipment which it is claimed develops desired product quality in minimum time with maximum efficiency and with the use of automated and compact equipment.

Selas automated, high-speed furnaces are described for nearly every department of the modern steel mill: rolling mill and forge shop, foundry, strip mill, tube mill, bar and wire mill, galvanizing and tinning shops, coke-oven by-product plant, and laboratory. A separate section is devoted to the heating of workpieces having heavy cross-section and unusual shape.

For further information circle No. 19

AUTOMATIC ELECTRODE CLAMPING DEVICE

An 8-page illustrated booklet citing the economy and safety advantages gained through automatic electrode positioning has just been published by the Whiting Corporation, Harvey, Ill., manufacturers of Hydro-Arc Electric Furnaces.

Titled "Electrode Arms and Clamps," the booklet contains an exploded drawing that details the functional simplicity, safety and economy features of the gentle arm and clamp that allows electrodes to "float *on* a cushion of air . . . be clamped *with* a cushion of air."

For further information circle No. 20

VACUUM DATA SHEETS

Two technical data sheets are now available from the High Vacuum Equipment Corp., Hingham, Mass., which describe their high production vacuum metalizing unit and the high vacuum bell jar unit.

The vacuum metalizing unit is a 72" coater used in the coating of reflectors, automobile trim, household appliances, and for all types of low-cost finishing of metal, plastic, and glass. The bell jar unit is a compact, self-contained unit for vacuum evaporation of either reflective or non-reflective coatings.

For further information circle No. 21

TOOLROOM BOOKLET

A popular booklet published several years ago by Lindberg Engineering Company, Chicago, is still up to date and available now. It is entitled "How to Plan Your Toolroom Heat Treating Department."

This 24-page, illustrated book shows many layouts for small to large toolrooms, lists the auxiliary equipment needed such as tanks, benches, inspection equipment and even various types and sizes of tongs. In addition, all of the various types of toolroom furnaces are described which can be used for brazing, carburizing, ni-carbing, and other special atmosphere work.

For further information circle No. 22

INDICATING-CONTROLLING PYROMETER

The Illinois Testing Laboratories, Inc., Chicago, has introduced a new temperature controller referred to as the "Alnor" Pyrotroller. This instrument is a pyrometer controller which means that it can be applied wherever a thermocouple can be used to measure temperature. A six-page, illustrated bulletin describing it in detail is available.

For further information circle No. 23

DESCALING CORROSION-RESISTANT ALLOYS

Turco Products, Inc., Los Angeles, has published an 8-page illustrated technical data bulletin explaining their descaling process for use on such high temperature, corrosion-resistant alloys as stainless steels, titanium and nickel alloys, and other high strength alloys.

The descaling process involves the application of a Turco pretreatment compound on metal surfaces prior to thermal treatments, and the descaling is said to be accomplished without excessive metal loss, intergranular attack, smutty residues, hydrogen contamination, etching or pitting.

For further information circle No. 24

ENVIRONMENTAL TESTING EQUIPMENT

The Atlas Engineering Corp., West Hartford, Conn., has published a 4-page illustrated booklet describing their series of temperature, altitude, and humidity environmental testing equipment.

For further information circle No. 25

PUSHER FURNACES

C. I. Hayes, Inc. offers a bulletin describing their complete line of high-temperature pusher furnaces with ceramic heating elements for temperatures up to 2400°F.

These furnaces are offered in three styles: (1) with open chamber and exposed heating elements, (2) with refractory muffle, and (3) with metallic muffle. Designed and constructed for use with a wide range of protective atmospheres, Type BA Furnaces are widely used for bright treatment of stainless steels, nicro-brazing, sintering of powder metal parts, copper brazing, the heat treatment of moly and tungsten high speed steels, air hardening of high carbon, high chrome steels and ceramic metallizing.

For further information circle No. 26

UNIVERSAL ELECTRONIC RECORDER

A bulletin - specification sheet package of literature has been prepared on the New Hays Universal Electronic Recorder. Included in the literature are details on the available two types of electronic receiver units (slidewire and differential transformer types), direct pressure and temperature receivers, Universal Amplifier, integrator and accessories.

The instrument is presently available for recording of pressure, temperature, flow, liquid level, $\%O_2$, $\%CO_2$, $\%H_2$, pH, speed, combustibles, BTU, and customer specified input motion.

For further information circle No. 27

"HEAT TREAT REVIEW"

The latest issue of "Heat Treat Review" published by Surface Combustion Corp. features a dramatic color photograph of a "walking beam" furnace used in the heat treatment of space and aircraft forgings. An article describing this interesting installation accompanies the photo.

Other articles cover: A discussion of modern brazing equipment used in conjunction with prepared atmospheres; a case history of a high speed atmosphere furnace with the unique feature of sectional construction used to heat copper in an eastern rolling mill; and also an article on the current and vital subject of dewpoint control.

For further information circle No. 28

INDUSTRIAL OIL PRODUCTS

A new booklet gives information on Sun Oil Company's complete line of industrial products—general and specialty lubricants, greases, mine lubricants, diesel lubricating oils, cutting, quenching, and other metalworking oils, hydraulic oils, heat-transfer oils, rubber process aids, waxes, petrochemicals, spray oils, solvents, refrigeration oils, electrical oils, and textile machine oils.

A handy reply card is included for request for further information on any of the products listed in the new bulletin.

For further information circle No. 29

APPARATUS CATALOG

The availability of a new 175-page catalog illustrating and describing more than 450 different pieces of instruments and apparatus was announced recently by Labline, Inc., Chicago.

The 1959 catalog has embossed leatherette covers with multi-ring binders, and illustrates and describes such items as constant temperature baths; drying ovens; environmental units for humidity, altitude and low temperatures; an extensive line of petroleum testing equipment; sectional laboratory furniture; bench and floor model centrifuges; ALUMALOY clamps; walk-in ovens; reach-in ovens to 1000°F.; incubators; incubating rooms; refrigerated baths; constant temperature cabinets; serological baths, meters; humidity indicators; and other useful apparatus for the laboratory and plant.

For further information circle No. 30

CONVEYOR SYSTEMS

The A. F. Holden Company, Detroit, has published a technical bulletin "Conveyor Systems for Plating Processes and Salt Bath Heat Treating." This 12-page book is illustrated and contains schematic drawings of the various kinds of conveyor systems for all plating processes and explains how these systems can be used with various automatic salt bath heat treating equipment.

For further information circle No. 31

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